

MARK SCHEME for the May/June 2013 series

9701 CHEMISTRY

9701/21

Paper 2 (AS Structured Questions), maximum raw mark 60

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

| Page 2 | Mark Scheme | Syllabus | Paper |
|--------|--------------------------------|----------|-------|
| | GCE AS/A LEVEL – May/June 2013 | 9701 | 21 |

- 1 (a) (i) $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ (1)
- $(\text{NH}_4)_2\text{SO}_4 + 2\text{NaOH} \rightarrow 2\text{NH}_3 + \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$ (1)
- allow ionic equations in each case
- (ii) $n(\text{NaOH}) = n(\text{HCl}) = \frac{39.2 \times 2.00}{1000} = 0.0784$ (1)
- (iii) $n(\text{NaOH}) = n(\text{HCl}) = \frac{29.5 \times 2.00}{1000} = 0.059$ (1)
- (iv) $n(\text{NaOH}) = 0.0784 - 0.059 = 0.0194$ (1)
- (v) $n[(\text{NH}_4)_2\text{SO}_4] = \frac{0.0194}{2} = 9.7 \times 10^{-3}$ (1)
- (vi) mass of $(\text{NH}_4)_2\text{SO}_4 = 9.7 \times 10^{-3} \times 132.1 = 1.2814 \text{ g}$ (1)
- (vii) % of $(\text{NH}_4)_2\text{SO}_4 = \frac{1.2814 \times 100}{2.96} = 43.30405405 = 43.3$
 give one mark for the correct expression (1)
 give one mark for answer given as 43.3 – i.e. to 3 sig. fig. (1)
 allow ecf where appropriate [9]
- (b) fertiliser in the river causes
 excessive growth of aquatic plants/algae **or** algal bloom (1)
 when plants and algae die O_2 is used up **or** fish or aquatic life die (1) [2]
- (c) manufacture of HNO_3 **or** explosives **or** nylon **or**
 as a cleaning agent **or** as a refrigerant
not detergent (1) [1]

[Total:12]

| Page 3 | Mark Scheme | Syllabus | Paper |
|--------|--------------------------------|----------|-------|
| | GCE AS/A LEVEL – May/June 2013 | 9701 | 21 |

2 (a) $K_p = \frac{p(\text{NO})^4 p(\text{H}_2\text{O})^6}{p(\text{NH}_3)^4 p(\text{O}_2)^5}$ (1)

atmospheres **or** Pa **or** kPa (1)
allow ecf on incorrect powers [2]

(b) (i) **increasing temperature**

yield of NO is decreased **or** reaction moves to LHS (1)

forward reaction is exothermic (1)

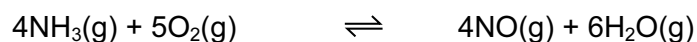
(ii) **decreasing the pressure**

yield of NO is increased **or** reaction moves to RHS (1)

more moles/molecules of gas on RHS **or**

fewer moles/molecules of gas on LHS (1) [4]

(c) let ΔH_f^\ominus for NO be $y \text{ kJ mol}^{-1}$



$$\Delta H_f^\ominus \quad 4 \times (-46.0) \qquad \qquad \qquad 4y \qquad \qquad 6 \times (-242) \qquad \qquad \qquad (1)$$

$$\begin{aligned} \Delta H_{\text{reaction}}^\ominus &= 4y + [6 \times (-242)] - [4 \times (-46.0)] & (1) \\ &= 4y - 1452 + 184 \end{aligned}$$

$\Delta H_{\text{reaction}}^\ominus$ is -906 kJ mol^{-1} so

$$4y = -906 + 1452 - 184 = 362 \qquad \qquad \qquad (1)$$

whence $y = \Delta H_f^\ominus$ for NO = $+90.5 \text{ kJ mol}^{-1}$

+ sign is required (1) [4]

[Total: 10]

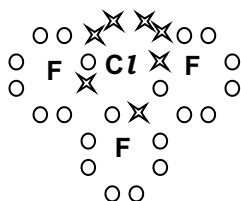
| Page 4 | Mark Scheme | Syllabus | Paper |
|--------|--------------------------------|----------|-------|
| | GCE AS/A LEVEL – May/June 2013 | 9701 | 21 |

3 (a) penalise (–1) for names of elements

- (i) Na or K or Li (1)
- (ii) S or C or N or P (1)
- (iii) K (1)
- (iv) C (1)
- (v) Cl (1)
- (vi) Al or Si (1) [6]

- (b) (i) Al_2O_3 or SiO_2 (1)
- (ii) Na_2O (1)
- (iii) P_2O_3 or P_4O_6 and P_2O_5 or P_4O_{10} or SO_2 and SO_3 (1+1)
- (iv) Al_2O_3 (1) [5]

(c) (i)



- 3 bonding pairs and
2 lone pairs around Br atom (1)
- 3 lone pairs on each of the F atoms (1)

(ii) either

referring to van der Waals' forces in BrF_3

- van der Waals' or
intermolecular forces are greater/stronger (1)
- because there are more electrons in BrF_3 than in ClF_3 (1)

OR referring to permanent dipoles

- permanent dipole or intermolecular forces are stronger/greater in BrF_3 (1)
- because BrF_3 has a larger permanent dipole than ClF_3

- OR because difference in electronegativity is larger between Br and F than between Cl and F (1)

part (ii) has a maximum of 2 marks (max 2) [4]

[Total: 15]

| | | | |
|---------------|---------------------------------------|-----------------|--------------|
| Page 5 | Mark Scheme | Syllabus | Paper |
| | GCE AS/A LEVEL – May/June 2013 | 9701 | 21 |

4 Types of reaction used must come from the list in the question.

| organic reaction | type of reaction | reagent(s) |
|---|---|--|
| CH ₃ CH ₂ CH ₂ CH ₂ Br → CH ₃ CH ₂ CH ₂ CH ₂ NH ₂ | nucleophilic (1) substitution (1) | NH ₃ (1) |
| CH ₃ CH ₂ CH ₂ CH ₂ OH → BrCH ₂ CH ₂ CH ₂ CH ₂ OH | free radical (1) substitution (1) | Br ₂ or Br ₂ in an organic solvent (1) not Br ₂ (aq) |
| CH ₃ COCH ₃ → CH ₃ C(OH)(CN)CH ₃ | nucleophilic (1) addition (1) | HCN or HCN and CN ⁻ or NaCN/KCN + H ⁺ (1) |
| CH ₃ CH(OH)CH ₂ CH ₃ → CH ₃ CH=CHCH ₃ | elimination (1) not dehydration | conc. H ₂ SO ₄ or P ₄ O ₁₀ or Al ₂ O ₃ or H ₃ PO ₄ (1) |

[Total: 11]

| | | | |
|--------|--------------------------------|----------|-------|
| Page 6 | Mark Scheme | Syllabus | Paper |
| | GCE AS/A LEVEL – May/June 2013 | 9701 | 21 |

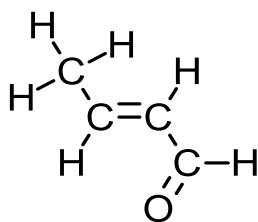
5 (a)

| reaction | reagent | product |
|----------|---|--|
| A | Br ₂ in an inert organic solvent | CH ₃ CHBrCHBrCHO |
| B | PCl ₃ | NO REACTION |
| C | H ₂ and Ni catalyst | CH ₃ CH ₂ CH ₂ CH ₂ OH |
| D | NaBH ₄ | CH ₃ CH=CHCH ₂ OH |
| E | K ₂ Cr ₂ O ₇ /H ⁺ | CH ₃ CH=CHCO ₂ H |

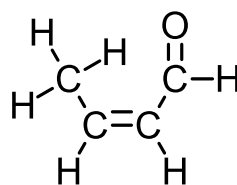
one mark for each correct answer

[5]

(b)



trans or E



cis or Z

two correct structures

(1)

both correctly labelled

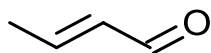
(1)

correctly displayed -CHO group

(1) [3]

| | | | |
|---------------|---------------------------------------|-----------------|--------------|
| Page 7 | Mark Scheme | Syllabus | Paper |
| | GCE AS/A LEVEL – May/June 2013 | 9701 | 21 |

(c)



(1) [1]

(d) (i) $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CO}_2\text{H}$

(1)

(ii) $\text{CH}_3\text{CO}_2\text{H}$
 $\text{HO}_2\text{CCO}_2\text{H}$

(1)

(1) [3]

allow ecf on candidate's answer to E in (a)

[Total: 12]